# Analysis of Samples Returned from Space

## Scientific Achievement

A new Resonance Ionization Mass Spectrometry (RIMS) instrument has been developed which meets the stringent analytical requirements of samples returned from space. The RIMS instrument performs quantitative mass analyses at concentrations, not achievable by other method, while consuming little sample, permitting new and exciting scientific investigations. Several instrument design innovation have been developed. Of particular importance is instrument sensitivity as measured with the parameter, useful yield (atoms detected per atoms consumed). The new instrument has a useful yield approaching 20%, indicating that 1 out of every 5 atoms removed from a surface reaches the detector. Also of significance is the use of a time of flight mass spectrometer, so that all masses are detected thus minimizing sample consumption. The instrument incorporates (1) dual ion beam analysis for cleaning and high resolution depth profiles, (2) in situ optical microscope with sub-micrometer resolution, and (3) secondary electron imaging. All three of these features are important for analysis of Genesis solar wind samples, due to the crash of the space craft and surface contamination of the samples with terrestrial material. The first Genesis solar wind sample has already been analyzed. A depth profile of Mg in a solar wind collector was determined and the dose of $^{24}Mg$ was determined to be $1 \times 10^{12}/cm^2$. Elemental fractionation between the solar wind and the sun will be determined from the RIMS analyses. The abundances of many high z elements in the solar wind are unknown and will be determined by RIMS for the first time. Multi-element RIMS analyses allow micrometer grains to be analyzed despite their limited number of atoms. Soon samples from the Stardust mission will be received by our laboratory for analysis also.

## Significance

Understanding the formation of the solar system requires knowledge of the compositions of the sun and other non terrestrial bodies. NASA's Genesis and Stardust Discovery Missions collected samples in space and returned them to Earth. The purpose of Genesis was to collect solar wind, the material ejected from the sun. Various high purity materials, which acted as collectors for solar wind, were returned to Earth in September 2004 and are now available for analysis. These samples contain a record of the elemental and isotopic abundances of the solar wind implanted in the near-surface region of the collectors. Particles from comet Wild II and interstellar dust streaming through our solar system were collected in aerogel and returned to Earth by Stardust. The total mass of material collected is small making these samples extremely rare and valuable. These samples are important for a better understanding of the creation of our solar system. Solar system formation models will be constrained and improved by RIMS quantification of many elements in the solar wind. RIMS measurements of the elemental and isotopic abundances of particles gathered from a comet are the earliest record of material from the solar nebula.

## Performers

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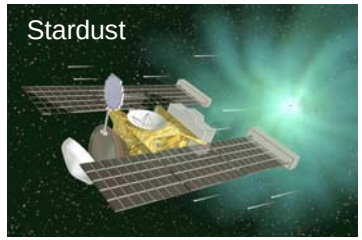
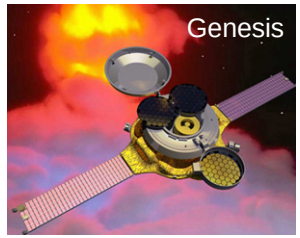
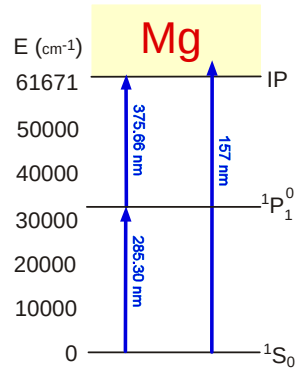
- Resonance Ionization Mass Spectrometry (RIMS) is being used to measure composition and isotopic abundances of samples returned from space.

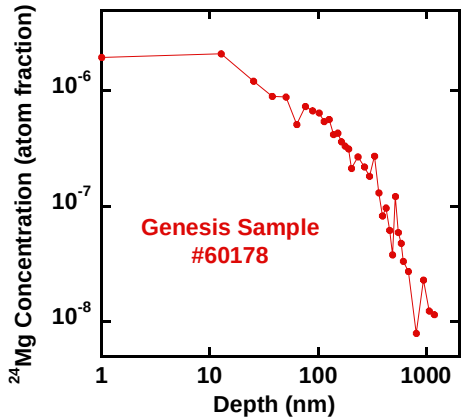



- The RIMS instrument performs quantitative mass analyses at concentrations, not achievable by other method, while consuming little sample, permitting new and exciting scientific investigations.




- Solar system formation models will be constrained and improved by RIMS quantification of many elements in the Genesis solar wind samples.
- RIMS measurements of the elemental and isotopic abundances of particles gathered from Comet Wild during the Stardust mission will yield results that investigate the earliest record of material from the solar nebula.

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